APPENDIX -V
PROPOSED TERMS OF REFERENCE (TOR)
FOR EIA & EMP STUDY

1.0 Introduction

The newly formed Andhra Pradesh Capital Region comprises of rapidly growing Vijayawada, Guntur cities and 9 towns such as Tenali, Mangalagiri etc., along with the new capital city – Amaravati. As part of the post-bifurcation projects, in pursuance of connecting the new capital city with Rayalaseema region, Government of Andhra Pradesh has decided to construct Access Controlled expressway from Ananthapuramu to Amaravati. The proposed expressway between Amaravati and Ananthapuramu encompasses the vision to reduce the travel time from Rayalaseema to Amaravati to four/five hours thus providing a faster connectivity to the people of the region to reach their capital city. A quick connection is formed, in the form of an expressway, between two capital cities of Bengaluru and Amaravati. Strategically located between Bengaluru and Amaravati, Rayalaseema region benefits hugely in terms of attracting industrial/commercial investments and promoting tourism. This in turn will change the economic face of the region from scratch to prosperity. In the long run, the project stretch will support the region's growing population and will spur the creation of huge employment in the region. Keeping such development aspects in view, Govt. of Andhra Pradesh*, through R & B wing,* wishes to study the feasibility of providing an expressway in the new state to fasten the economic growth.

Government of Andhra Pradesh has appointed M/s. Aarvee Associates Architects Engineers & Consultants Pvt. Ltd. (*herein after referred to as Consultant*) to provide consultancy services for "Preparation of Techno-Economic Feasibility Report of Four Lane/Six Lane Expressway connecting New Capital City Amaravati to Ananthapuramu with connectivity to Kurnool and Kadapa in the State of Andhra Pradesh". As part of the study, Consultant had undertaken reconnaissance and map studies of the influence area for identifying the existing road network, land use pattern and industrial activities along the project corridor stretching from Amaravati to Ananthapuramu.

2.0 Project Description

The proposed expressway connects the new capital city of Andhra Pradesh, Amaravati with Ananthapuramu in Rayalaseema with feeder road expressway. The spinal corridor

takes off from NH-44 near Maruru in Ananthapuramu district and ends at Pedaparimi near Sakhamuru (which is a neighborhood & a part of Amaravati). Few fragments of proposed expressway pass through Nallamala Forest area. The expressway traverses across the districts of Ananthapuramu, Kurnool, Prakasam and Guntur. The road from Ananthapuramu is designed to be four-lane. Six-lane road starts from Yedavalli, which forms a single stretch to the state capital. The project stretch is designed to have a straight alignment, thus offering shorter distances and travel times to the commuters. The details of project stretch are presented in **Table 1**. The expressway is designed as high-speed corridor by making it completely access-controlled.

Table 1: Details of Project Corridor

S. No.	Stretch	Length (km)	Major Settlements Nearby	District
1	Ananthapuramu – Yadavalli (4 lane)	173	Ananthapuramu, Narapala, Kadavakallu, Tadipatri, Allagadda, Giddalur, Yadavalli	Ananthapuramu, Kurnool, Prakasam
2	Yadavalli – Amaravati (6 lane)	211	Guddimetta, Cumbum, Dekanakonda, Nuzendla, Kommalapadu, Chilakaluripet, Nadendla, 113 Talluru, Medikonduru, Tadikonda	Prakasam, Guntur
Total Length of Expressway = 384 km				

The salient features of the project are given in the **Table 2** & **Table 3**.

Table 2: Salient Features of the Project Stretch

S. No.	Parameter	Ananthapuramu to Amaravathi Expressway
1	Location of Project	Ananthapuramu, Prakasam, Kurnool and Guntur Districts of Andhra Pradesh
2	Terrain	Project corridor predominantly passes through plain terrain (95%) followed by hilly terrain (4%) and rolling terrain (1%)
3	Major Settlement along the Project Stretch	Ananthapuramu, Narapala, Kadavakallu, Tadipatri, Allagadda, Giddalur, Yadavalli, Guddimetta, Cumbum, Dekanakonda, Nuzendla, Kommalapadu, Chilakaluripet, Nadendla, 113 Talluru, Medikonduru, Tadikonda
4	Rivers/ Streams/ Canals	
5	Forest area and Sanctuaries	Mutssukota RF, Sirivel RF, Nallamala RF, Ganugapenta RF, Uppumaguluru RF, Edavalli, Govindapuram & Kavuru RF
6	Length of the Proposed	384 km

S. No.	Parameter	Ananthapuramu to Amaravathi Expressway
	Alignment	
7	Proposed RoW	100 m for 4-lane/6 lane
8	Proposed Carriageway Width	
9	Administrative locations	
10	State	

Table 3: Other features of the Project Road

S. No.	Parameter	Ananthapuramu to Amaravathi Expressway
1	Design Speed	100 KMPH
2	Major Bridges	29
3	Minor Bridges	140
4	No. of Culverts (Box Culvert)	512
5	Railway Over Bridge (ROB)	5
6	Railway Under Bridge (RUB)	--
7	Vehicular Overpasses	9
8	Vehicular Underpasses	16
9	Foot Over Bridges	--
10	Bus Bays	--
11	Truck Lay Byes	--
12	Rest Areas	--
13	Toll Plazas	--
14	Bypasses	--
15	Total number of trees affected	39954
16	Tree plantation proposed (1:3 ratio)	523695
17	Land to be acquired	
18	Project Cost (Crores)	12897 cr.

2.1 Site and its Environs

The reconnaissance survey were carried out in the study area of the proposed project corridor passing through the districts of Kurnool, Kadapa, Ananthapuramu, Prakasam and Guntur districts in Andhra Pradesh. The major aspects emphasized with respect to the geographical, geology & soil, hydro-geology, and climatological conditions of the region are collected and

analyzed. This section contains a brief description on existing environment of the proposed project area in district wise.

2.1.1 Geographical features

The proposed project corridor passes through districts of Ananthapuramu, Kurnool, Kadapa, Prakasam and Guntur in Andhra Pradesh.

Ananthapuramu District:

It is bounded on the north by Kurnool District, on the east by Kadapa District, on the southeast by Chittoor District, and on the southwest and west by Karnataka State. The District is roughly oblong in shape, the longer side running North to South with a portion of Chitradurg District of Karnataka State intruding into it from west between Kundurpi and Amarapuram Mandals.

The District may be divided into 3 Natural Divisions. They are 1) Northern Mandal of Rayadurg, Kanekal, Beluguppa, Gooty, Guntakal, Vajrakarur, Uravakonda, Vidapanakal, Yadiki, Tadipatri, Putlur and Yellannur containing larger areas of Black Cotton soils 2) Kalyandurg, Kambadur, Settur, Brahmasamudram, Ramagiri, Kanaganapalli, C.K. Palli, Dharmavaram, Bathalapalli, Tadimarri, Mudigubba, Anantapur, Kudair, Pamidi and Peddavadugur in the center which are mainly made up of arid treeless, expense of poor Red Soils, (3) High Level Land of Pendukonda, Roddam, Gudibanda and Agali which connects with Mysore plateau at higher elevation of the rest of the District. This part has average sandy red soils of normal productivity.

Kurnool District:

Kurnool district is the third largest district of the State situated between North latitudes 14° 35′ 35″: 16° 09′ 36″ and East longitudes 75° 58′ 42″: 78° 56′ 06″. It is bounded by Tungabhadra, Krishna Rivers and Mahabubnagar district in the North and Prakasam district in the East, Bellary district of Karnataka State in the West and Anantapur and Kadapa districts in the South. It has an average elevation of 273 metres (898 feet). The major rivers of the region are Krishna and Penna and the important mountain ranges which cut the district from north to south are Nallamalas and Erramalas. Kurnool District has 54 mandals under 3 revenue divisions.

Prakasam District:

The district is located between 78.43 – 80.25 Eastern longitude and 14.57 – 16.17 Northern latitude Prakasam occupies an area of 17,626 square km. Towards the east of

Prakasam lies the Bay of Bengal, Cuddapah and Nellore lies towards the south of Prakasam, Prakasam is bounded by Kurnool in the west and Guntur in the north. The coastline of the district is as long as 105 kilometers.

Guntur District:

Guntur District is located at 16.20°N & 80.27°E. It has an average elevation of 33 metres (108 ft) and situated on the plains. There are a few hills in the surrounding suburban areas. The city is located around 40 miles (64 km) to the west of the Bay of Bengal on the east coast of India. The Krishna Delta lies partly in Guntur district.

2.1.2 Geology

Ananthapuramu District:

Ananthapuramu district is underlain by various geological formations ranging in age from Archaean to Recent. Major part of the district is underlain by the granites, gneisses and schists of Archaean and Dharwar Supergroup. Northeastern part of the district is occupied by the quartzites, limestones, shales of Cuddapah and Kurnool Group of rocks. Alluvium is restricted to Pennar, Vedavati and Papagni rivers.

Kurnool District:

Kurnool district is underlain by different geological formations ranging in age from Archaean to recent. The major part of the district in west is occupied by granite gneisses, while the eastern part is underlain by quartzites, shales and limestones of cuddapah and kurnool group. The recent alluvium is confined to the major stream and river courses like Krishna, Tungabhadra, Gundlakamma and Kuderu.

Prakasam District:

The area in Prakasam district is underlain by diverse type of rock types belonging to Achaean to recent age. The aquifer system in Prakasam district comprises 4 groups (1) Crystalline aquifer system, (2) Cuddapah aquifer system, (3) Gondwana aquifers and (4) Alluvial & laterite aquifer system. In general ground water occurs in all the formations of the area. Ground water occurs under phreatic conditions in the weathered, fractured crystalline rocks at shallow depths and under semi confined to confined conditions in the deeper fractured crystalline rocks. The crystalline aquifer, granite-gneiss, system occupy major parts of the district. The crystalline aquifer system lacks primary porosity and the occurrence, movement of ground water in these rock types depend on the thickness of weathered zone available and degree of fracturing/jointing.

Guntur District:

Guntur district is underlain by various geological formations of different age groups ranging from Archaean to Recent. The Archaean basement complex comprising the granite gneisses, Schists, Khondalites, Charnockites and basic dykes of dolerites form the predominant rock types in the central part. The fringe of the Archaeans in the central part is represented by Cuddapah basin, namely Nallamalai group of Upper Cuddapahs. In a sequential order, the younger Kurnools occurring in the Cuddapahs and those in the western parts of the district are thrust over by the Cuddapahs and these in turn by the Archaean granite-gneisses. The Upper Gondwana group of sandstones and shales out crop are seen at places between Guntur and Tenali. The youngest rock types of the district appear to be of Mio- Pliocene age followed by the Alluvial deposits of Recent to Sub-Recent age.

2.1.3 Soil

Ananthapuramu District:

The soils of Anantapur district are predominantly of red and black types. It is estimated that 82 percent of the area is of red soil and 18 percent of the area is a black soil. The soils of the district have been classified according to soil-taxonomy based on study of physiography drainage, lithology and land forms and their relationship using remote sensing data. The visual interpretation techniques are extensively employed in deriving information on soils are delineated based on characteristic of gray tone, texture, pattern, shape and size. The various categories of soils of Anantapur district are broadly classified into six types. 1) Yellowish Brown to Grey Brown Alluvial and Colluvial sands. 2) Reddish Brown to Brown fine Loamy, Clayey Soils. 3) Reddish Brown to Brown Coarse to fine Sands. 4) Very Dark to Grey fine Clayey soils with Calcareous Crusts. 5) Lateritic soils with Lateritic Gravel. 6) Gritty or Skeletal Soils.

Kurnool District:

The soils in the district are classified as clay, loamy and sandy soils. The black cotton soils are predominant in the mandals of Pattikonda, Nandyal, Allagadda, Koilkuntla, Nadikotkur and Adoni. In the eastern part of the district, red soil of a poor quality largely predominates. These soils although, generally poor in fertility, yield a very good crop with a minimum rainfall. Regar soils are predominant in the mandals of Kurnool and Pattikonda. The availability of alluvial soil is quite small and is confined to a few villages near the Banavasi and the Krishna.

Prakasam District:

The district has variety of soils like black cotton, red soil, red sandy loamy and sandy loamy.

Guntur District:

The black cotton and red loamy soils are predominant in the district 69 per cent of the total area of the district is black cotton while 24 per cent of that is the red loamy soils. The soils of the district are broadly divided into alluvial regar, red and arenaceous and are further subdivided into clayey, loamy and sandy. Of these alluvial soils occupy 7 per cent, while 53 per cent fall under regar series, 38 per cent under red and the remaining 2 per cent is covered by the arenaceous series.

2.1.4 Minerals

Ananthapuramu District:

Barytes high grade lime stones, iron ore and steatite are the minerals available in the district. There are, however no large sized minerals occurring in the district. Diamonds are said to be available near Vajrakarur mandal. They mainly occur in pipe rocks. Gold is found to occur in the cholite schist's and physlite along with western parts of Darwar Schist and belt at Ramagiti village in Ramagiri mandal in the district. The area covers with length of 14 kms. Exploratory mining in the area is pruned about 467 meters of ore shoots with an area width of 100 cms/ton. 24 mandals representing 38% out of 63 mandals have mineral resources in the district. Some of the important mineral resources are gold, diamond, building stones, mosaic ships, cubes, red oxide, road metal, granite, steatite, limestone, white shale and clay and barites etc.

Kurnool District:

Kurnool District is well known for its mineral resources especially for limestone deposits. Lime Stones of this district are of flagstones, cement grade lime stones. Narji lime stones are found in Dhone, Kurnool, Nandikotkur, Koilakuntla and in several areas of the district. The Narji Lime Stones contain both massive and flaggy lime stones. The massive deposits are used in cement manufacture while the flags are quarried as building material. Major outcrops of Narji lime stones are found at Sathanikota, Bukkapuram and Bethamcherla. Lime Stones are seen along a ridge near Bukkpuram. The Limestone in this area are of three types consisting of light grey brown or pink coloured, splintery limestone at the bottom, massive thick bedded light to dark bluish or ash grey lime stones in the middle and dark grey calcareous flags at the top. Narji limestone in this area is composed of bands of varying thickness, differing in physical and chemical

characters. Seven different bands of cement grade limestones have been recognized based on their colour and other physical characters. The limestones of this area are grey and flaggy. The limestones at base are thick bedded, slaby and splintary.

Prakasam District:

Prakasam is one of the leading district in granite mining in the State with discovery of "Galaxy Granite" in the Chimakurthy area of the district. Good deposits of coloured granites are located occur around Uppumangaluru and Kodidena. The minerals found in the district are Baryte, iron ore, quartz, and silica sand. In 2010-11, 4,300 tonnes of Baryte, 22,722 tonnes of quartz, 2,24,075 tonnes of silica sand and 400 tonnes of iron ore were produced in the district.

Guntur District:

Guntur district has deposits of limestone, clay, quartz, copper, and lead. Lime stone is abundantly available in Pidiuguralla, Macherla, Pondugula and Tadipalli areas. Copper deposits are found at Agnigundala. Napa stones are found in abundance in various places in this district.

2.1.5 Hydro geology

The hydro geology profile of the district is extracted from the Central Ground Water Board Literature for the districts.

Ananthapuramu District:

The district is underlain by granite gneisses and schists of Archaean age and formation of Cuddapah Super Group belonging to upper Precambrian to lower Paleozoic Age. River alluvium occurs along the major river courses and to some extent along minor stream courses. The Archaean crystalline rocks include granites, gneisses and Dharwarian schists. The ground water in these formations occurs in the weathered and fractured zones under water table and semi-confined conditions respectively. These rock types do not posses primary porosity. Due to fractured and weathering, they have developed secondary porosity often giving rise to potential aquifers at depth. The degree of weathering in the Archaean formation is less than 20 m. This weathered zone has been tapped extensively by the dug wells and dug-cum-bore wells, which invariably tap the fractures occurring below the weathered zone. Ground water occurring in these formations is generally developed by dug-cum-bore wells and bore wells. The depth of open wells range from 6.0 to 25.0 m below ground level and depth to water level vary from 1.5 to 23 m bgl. The yield of dug wells varies from 10-200 cu.m/day for a pumping period of 3 to 6 hrs a day.

Kurnool District:

Ground water occurs in all the geological formations in Kurnool district. The crystalline rocks develop secondary porosity through fracturing and subsequent weathering over ages and become water bearing. Movement of ground water is controlled by degree of inter-connection of secondary porosity and voids. The depth of weathered zone ranges from few centimeters to 18 m bgl. Ground water occurs under unconfined conditions in shallow weathered zones and under semi-confined conditions in joints, fissures and fractures. Occurrence of joints and fissures extends down to depth ranging from 20 to 100 m bgl. The shallow aquifers are developed through large diameter irrigation wells and domestic wells. The depth of irrigation wells ranges from 4 to 26 m bgl. Irrigation wells sustain pumping of 2 to 4 hrs per day during summer. Ground water occurs in the aquifers of Kurnool formations in Panyam Quartzites under unconfined and semi-confined conditions in weathered zone, sheared zones, joint planes and bedding contacts. The depth of dug wells varies from 7-13 m bgl., with extension bores down to a maximum depth of 15 m. The yield of wells ranges from 30 to 100 cu.m/day. In Koilkuntla limestone, ground water occurs under unconfined conditions in the top weathered zones and karstified horizons. Ground water occurs under unconfined condition in Nandyal shales down to a limited depth of 30 m bgl. The thickness alluvial aquifers varies from less <1 to 8.0 m and depth to water ranges between 1.0 and 5.3 m bgl. Transmissivity of the aquifers in granitic gneisses in western part of the district in Vedavati River Basin ranging from 585 to 1370 sq.m/day and in Tungabhdra canal command area it is varying from 1 to 210 sq.m/day. The specific capacity of wells varied from 5.92 to 49.78 lpm/m of draw down. Transmissivity values range from 67 and 1910 sq.m/day in Cuddapah and Kurnool formations.

Prakasam District:

The area in Prakasam district is underlain by diverse type of rock types belonging to Achaean to recent age. In general ground water occurs in all the formations of the area. Ground water occurs under phreatic conditions in the weathered, fractured crystalline rocks at shallow depths and under semi confined to confined conditions in the deeper fractured crystalline rocks. The crystalline aquifer, granite-gneiss, system occupy major parts of the district. The crystalline aquifer system lacks primary porosity and the occurrence, movement of ground water in these rock types depend on the thickness of weathered zone available and degree of fracturing/jointing. The thickness of weathered zone varies from 3.0 to 15.0 m. The depth of the dug wells ranges from 6.0 to 16.0 m bgl with yields of the wells varying from 50 to 100 m^3/day and sustain intermittent pumping for 3 to 6 hours a day. In the Hornblende – Biotite – Gneiss the discharge is

14.0 to 155.52 m^3/day and the Transmissivity is 12.66 to 150 m^2/day. Yield varies from 38 m^3/day to 158.97m^3/day with Transmissivity values from 1.5 to 12.66 m^2/day in Charnockite formations. In schistose formations the discharges varied from 63.07 m^3/day to 242 m^3/day with Transmissivity of the aquifer varying from 1.06 m^2/day to 40 m^2/day. The Cuddapah aquifer system consists of Quartzites, shales and limestones. The occurrence and movement of ground water in these rocks depending on the extent of weathering, degree of compaction, fracturing and occurring of bedding planes and presence of solution channels in the limestones. The dug wells range in depths between 8.0 to 15.0 m bgl. and the yields range from 20 to 120 m^3/day. Ground Water exploration down to 150 m depth, yield in this formation vary 172.80 m^3/day to 587.52 m^3/day with Transmissivity of the aquifer varying from 6.87 m^2/day to 158.22 m^2/day. In shale formation the discharge varied from 164.20 m^3/day to 316.26 m^3/day and the Transmissivity values varying from 6.59 m^2/day to 22.8 m^2/day.

Guntur District:

Archaean crystalline formations are the predominant water bearing formations with lack of primary porosity. Secondary porosity was developed through fracturing and subsequent weathering over ages and become water bearing at hydro geologically favorable locations. The depth of weathered mantle ranges from about 8 to 15 m bgl and below this zone fractured rocks are known to occur down to 40.0 m bgl. The depth to water level ranges from less than a meter to 12 m bgl. The weathered zone has been tapped extensively by the dug wells and sustain four to six hours of pumping with yield 10 to 80 or up to 200 m^3/day, and capable of irrigating about 0.8 to 3.0 hectares. Ground water occurs in the joints, bedding planes and the weathered portion in Cuddapah and Kurnool group of rocks. The Quartzites formations do not form good aquifers because of their compactness and occurrence at high relief. The ground water is developed in slaty phyllite by dug, dug-cum bore wells and few bore wells. The depth of wells varies from 3 to 25 m bgl, with moderate to very poor yields ranging between 10 to 70 m^3/day. The depth to water levels range from 0.4 to over 7.0 m bgl, but in phyllite and slates it varies from 4 to 15 m bgl. The yield of wells ranges from 20 to 80 m^3/day, with exceptions in the highly fractured locations. The ground water occurs under water table and confined conditions in Gondwana formations. Ground water development in the area is by dug wells and bore wells. The depth to water ranges from 2.20 to 10.60 m bgl and the depth of dug wells varies between 5.50 and 18.50 m bgl. The tube wells in the area range in depth from 40.0 to 75.0 m bgl, with yield ranges from 28 to 1300 lpm for drawdowns of 8.0 to 15.0 m. The quality of ground water is potable. The thickness of alluvium varies from a few meters to over 100 m. The deltaic alluvium found in

palaeo/buried channels up to 30 m depth with thick graveliferous sand. Ground water is being developed in the flood plain areas along river course mostly through filter-points and shallow tube wells with yields ranging from 3 to over 15 lps as observed around Rayapudi and Borepalem areas of Amaravati and Thullur mandals. The depth to water level in the alluvium ranges from ground level to 5-12 m bgl with poor to moderate discharges. In deltaic alluvium ground water is brackish in nature. Quality of water in palaeo-channels, buried channels is potable and brackish to saline at shallow depths in the areas bordering the coast.

2.1.6 River basins in the Region

Ananthapuramu District:

Pennar is the important river in the district. Its origin is in Nandi Hills of Chikkaballapur district in Karnataka state where it is called Uttar Pinakini and enters into Anantapur district in the extreme south of Hindupur mandal and flows through Parigi, Roddam and again enters into Pavagada taluk of Karnataka, next enters into Ramagiri mandal, Kambadur, Kalyandurg, Beluguppa, Uravakonda, Vajrakarur, Pamidi, Peddavadagur, Peddapappur and Tadipatri mandals and finally enters Kadapa district. Another important river in the district is Chitravathi. Its origin in Devarayanadurga of Tumkur district of Karnataka state and enters into the district at Parigi mandal and join into Penna river at Sangameshwarapalli of Parigi mandal. It is also an important river in the district.

Kurnool District:

The major rivers of the district are Tungabhadra, Handri, Krishna, Kunderu and Gundlakamma. The river forms part of northern boundary of this district and separates Kurnool from the Telangana region. It falls into the Krishna at Kudali sangamam about 29 km from Kurnool town. The Krishna enters Kurnool district at Kudali sangamam. The river Kunderu starts on the Western side of the Erramalla, taking a northern course for a short distance passes into the Kunderu Valley and flows in the southern direction, collecting drainage all along its course form either side. It flows through Nandikotkur, Nandyal, Allagadda and Koilkuntal Mandals and finally joins into the Pennar near Kamalapuram in Kadapa district. The river Handri which is a tributary of the Tungabhadra flows through the Pattikonda mandal of Kurnool district.

Prakasam District:

The District is watered by the Gundlakamma, Manneru, Musi and Paleru Rivers besides small rivers like Thammileru, Sagileru and Gudisileru and streams like Ogeru vagu, Nalla vagu and Vedimangala vagu.

Guntur District:

The district is watered by mainly Krishna river which is the main source of water for the district through channels and tributaries. There are other smaller rivers and channels in the region such as Guntur Channel, Chandravanka, Naagileru, Guntur Branch Canal.

2.1.7 Sources of Irrigation and Cropping Pattern

Ananthapuramu District:

The district is served with both surface and ground water irrigation sources. Medium and minor irrigation projects exist in the district. The major irrigation project is Tungabhadra high level canal while medium irrigation projects include Upper Pennar, Bhairavathippa, Chinnarayaswamy, Pennar Kumbdavati and Yogi Vemana. The total net area irrigated is 1,42,386 ha by means of all sources of irrigation available in the district. The net area irrigated through canals, tanks and other sources are 22,836 ha, 898 ha and 1,548 ha. The net area irrigated through dug wells and bore/tube wells is 5,578 ha and 1,23,050 ha. Prominent crops include groundnut, sunflower, rice, cotton, maize, Chillies, Sesame, and sugarcane.

Kurnool District:

The major irrigation projects in the district are Tungabhadra High level Canal, Tungabhadra low level Canal, K.C Canal, Gajula Dinne and Telugu Ganaga Project. As per 2011-2012, the canal irrigation accounts for 1,30,156 ha., tank irrigation accounts for 8,264 ha whereas an area of 1,20,053 ha is irrigated by ground water. Out of gross irrigated area of 2,98,842 ha, about 1,38,420ha (47%) is being irrigated by surface water and the remaining area of 1,12,779 ha (38%) by ground water and remaining from other sources. There are 26,000 dug wells and 86,379 bore wells in the district. The main crops raised are paddy, groundnut, jowar, cotton, bajra, tobacco and sugarcane.

Prakasam District:

The principal crops grown in the district are paddy, jowar, maize, ragi, pulses. The net area sown is 607633 ha. As per 2012 data the area irrigated through canals 83811 ha;

tank irrigation 12360 ha; tube wells and filter point wells irrigate 1165941 ha., and through other sources 15821 ha. The gross area irrigated in the district is 2,44,901 ha. Net area irrigated is 2,32,421 ha.

Guntur District:

Major irrigation projects in the district are Krishna Delta and Nagarjuna sagar project while the minor irrigation projects are Guntur Channel and MI schemes. The area irrigated during the year 2010-11 through these canals is 3,01,037 Ha., and through ground water is 77,442 Ha., Irrigation from the other sources 16,920 Ha., and through tanks 5,422 Ha. The district is blessed good network of irrigation canals of the Nagarjunasagar Right Canal Command Area, Krishna Western Delta Canal System and Guntur Channel Scheme. Paddy, Cotton, Maize, Black gram and Regram are the major cultivated crops in the district. Various fruits grown in the region are Banana, Lemon, Orange, Papaya and Mango while vegetables grown are Chillies, Bhendi, Gourds, Cucumber and Brinjal.

2.1.8 Industries

The industrial profile of the districts through which the proposed alignment is passing is given in this section. The industrial profile of the districts is extracted from the MSME literature of the districts.

Ananthapuramu District:

There are nearly 1926 units of agro based industries, 902 cotton textile units, 480 wooden based units, 288 chemical based and 700 metal based existing micro & small enterprises and artisan units in the district. In Anantapur district Nimmalokunta Leather puppetry is the famous handicraft existing and exportory item. Anantapur has got a very strong hand loom base. The world famous Dharmavaram silk and cotton sarees are the products of this district. Asan allied to it, the ready made garment manufacturing activity is also well established at Pamidi, Rayadurg and Anantapur. Dharmavaram sarees are exporting item. The district has rich deposits of good mineral resources like iron ore, lime stone, cement grade gold deposits, many diamonds will available in and around Vajrakarur, white shale, dolomite and barites. About 100 mineral units are existing at Tadipatri and Yadiki Mandals. Minerals products products are exporting item.

Kurnool District:

There are nearly 433 units of non metallic mineral based, 41 rubber & plastic, 186 food based, 18 chemical based and 18 tobacco based existing micro & small enterprises and

artisan units in the district. Kurnool district has a number of Oil mills, textile mills, stone polishing units, cement plants, and chemical industries. MSE units may benefit from the backward and forward linkages that these units provide. There is scope for manufacture of spares and components of these firms, and manufacture of essential parts like bearings, bolts and nuts, abrasive materials, grinders, industrial gloves, effluent treatment plants etc. Granite slabs, polished stones and rice are the major exportable items in the district. Kurnool district is famous for Bathemcherla stones in Bathemcherla town and Ground nut oil mills cluster of Adoni, artificial diamonds and artificial jewelery of Kurnool, Carpets and Dhurries cluster of Adoni, Cane and Bamboo cluster of Ahobilam, and stone carving cluster of Allagadda. Of these, Bethamcherla Stone cluster and Adoni Oil mills cluster are thriving clusters.

Prakasam District:

There are nearly 1046 units of agro based industries, 309 engineering & allied, 665 food based, 495 chemical based and 1206 forest based existing micro & small enterprises and artisan units in the district. There were 30 Large and Medium enterprises in Prakasam district in the year 2006, involving an investment of 347 crores and providing employment to 7783 persons. In six years, the number of units has risen to 54 units (annual growth rate of 10.92%, employment grew at 17.58% (at current prices) and employment grew at only 3.8% pa). Major exportable items include granite slabs and monuments, processed tobacco and sea food. Prakasam district has clusters of hand looms, handicrafts and mineral products scattered around the district. Markapuram and surrounding areas have rich slate deposits, 18 while Chimakurthy is famed for the Galaxy granite deposits, not found any where else in the world. Chirala, Vetapalem, Ippurupalem, Chimakurthy and Kothapatnam, Kanigiri, Besthavaripeta, Inkollu and Naguluppalapadu and surrounding areas are famed for hand loom cloth and traditional weavings, while Addanki and surrounding areas have clusters of mat weaving and leaf fibre products. Aggarbathi makers are also many in Prakasam district.

Guntur District:

Guntur district has deposits of limestone, clay, quartz, copper, and lead. Lime stone is abundantly available in Pidiuguralla, Macherla, Pondugula and Tadipalli areas. Copper deposits are found at Agnigundala. Napa stones are found in abundance in various places in this district. Major ancillary items supplied to various industries include packing material like corrugated boxes, metal tins, containers, woven sacks, paper packing products, straps etc., for all units. Spares, bobbins, crates, packing materials for textile units. Plastic woven sacks, polishers, mechanical items for cement plants. Plastic covers,

tins, drums, packaging materials for milk plants. Major exportable items include Mang and other fruit products, Chillies, burnt lime, tobacco leaf and products. Guntur district has many clusters like Turmeric processing cluster, Duggirala, and Burnt lime cluster, Piduguralla, have been provided soft interventions under MSE-CDP scheme. The Health care industry cluster of Guntur and near by areas is being assisted through MSE-CDP Other clusters in the district are: Zari saris cluster at Guntur, Mangalgiri, Ilavaram Mosquito nets cluster at Chilakaluripeta, Phirangipuram, Nidubrolu, Mangalgiri Bed sheets cluster at Repalli, Tenali, Sattenapalli, Phirangipuram and Nidulbrolu Towels, Dhoties etc., at Tenali, Sattenpalli, Phirangipuram.

2.1.9 Transportation

The study districts are having a good transport system in the State of Andhra Pradesh. These are connected to all the major towns across the State through various major and local highways, railways and air. There are a couple of major highways in these districts and State Highways, MDRs, Panchayat roads etc., are also present in these districts. Common modes of road transport within the districts are city buses, cars and auto-rickshaws etc.

2.1.10 Infrastructure

The study region has well-developed infrastructural facilities in place. The power supply position is good and almost all the villages in the districts are electrified. The head quarters of all five districts in the study area have facilities like housing, hospital, drinking water, school and technical education, universities, medical college, recreational centres etc. Emergency medical care and fire fighting facilities are also available at all mandal/block head quarters along the districts of the proposed corridor.

2.1.10 Seismic Details of the Area

As per the seismic hazard map of India which was updated in 2000 by the Bureau of Indian Standards (BIS), the project area lies in Zones II as well as zone III. Ananthapuramu, Kurnool and Kadapa districts falls under the seismic zone II while Prakasam and Guntur falls under the seismic zone III. As classified in BIS map, Zone III indicates the moderate intensity zone, while zone II is the least seismically active region.

2.1.11 Archaeological Sites/Places of Tourist Interest

No archaeological sites were present with in the Right of Way (RoW) of the proposed corridor. However, each of the five districts have many tourist attractions and places of worship.

2.1.12 Forests, Biosphere and Sanctuary

Biological environment of the districts through which the alignment passes is presented in this section. The data is collected from the secondary source of Andhra Pradesh State Forest report of 2014.

The proposed Expressway of Anantpur to Amaravati Expressway project is passing through Mutssukota RF, Sirivel RF, Nallamala RF, Ganugapenta RF, Uppumaguluru RF, Edavalli, Govindapuram & Kavuru RF.

Ananthapur District:

Ananthapuramu District comprises of Ananthapur Division which lies in the South Western part of Andhra Pradesh.

- Anantapur Division's northern and central portions are a high plateau, generally undulating with large granite rocks or low hill ranges rising occasionally above its surface.
- Area of the notified forests of the Division is 1969.78 Km^2 which is 10.3% of the geographical area. Reserved, Protected and Un-classed Forests constitute 1921.48 Km^2 (97.54%), 14.73 Km^2 (0.7%) and 33.57 Km^2 (1.7%) of the total forest area respectively.
- As per Champion and Seth's classification, the Forests of the Division fall under Tropical Dry Deciduous, Tropical Moist Deciduous, Tropical Semi-Evergreen and Tropical Thorn Forest types.
- There is no Protected Area in the Division
- There are 281 Vana Samrakshana Samities (VSS) or Joint Forest Protection Committees (JFPC) in the Division covering an area of 628.35 Km^2, which constitutes 32% of forest area.
- The forest cover in the Division based on the Interpretation of IRS R2 LISS III 2012 data (Oct 2012) is 75.98 Km^2 which is 0.39% of the Geographical area. In terms of the forest canopy density classes, the Division has 5.18 Km^2 of Moderately Dense Forests and 70.80 Km^2 of Open Forests. The area of the Scrub is 767.27 Km^2, Non Forest 1098.46 Km^2 and Water Bodies 3.89 Km^2.

Kurnool District:

Kurnool District comprises of Kurnool, Atmakur WLM and Nandyal Division whose forest, protected area and land use pattern is being described below:

Kurnool Division:

- Kurnool Forest Division lies in the western part of Kurnool district. The rock formation consists of shales, limestone and quartzite.
- The notified forest area of the Division is 1202.55 Km^2 which is 9.58% of the geographical area. Reserved, Protected and un-classed forests constitute 1154.45 Km^2 (96%), 37.17 Km^2 (3.09%) and 10.93 Km^2 (0.91%) of the forest area respectively.
- As per Champion and Seth's classification, the forests of the Division fall under Tropical Dry Deciduous and Tropical Thorn Forest types.
- There is no Protected Area in the Division.
- There are 149 VSSs in the Division. An area of 392.62 Km^2 forests, which constitutes 32.65% of forest area, is under CFM.
- The forest cover in the Division based on the interpretation of IRS R2 LISS III 2012 data (Nov, 2012) is 149.1 Km^2 which is 1.15% of the geographical area. In terms of the forest canopy cover density classes, the Division has 1.13 Km^2 of Moderately Dense Forests and 147.97 Km^2 of Open Forests. The area of the Scrub is 356.11 Km^2, Non-Forests 696.01 Km^2 and Water Bodies 1.32 Km^2.

Atmakur WLM Division:

- Atmakur WLM Forest Division lies in the north-eastern part of Kurnool District. Area of the notified forest of the Division is 1288.81 Km^2 which is 59.83% of the geographical area. Reserved and Un-classed Forests constitute 1204.44 Km^2 (93.45%) and 84.37 Km^2 (6.54%) of the forest area respectively.
- As per Champion and Seth's classification, the forests of the Division fall under Tropical Dry Deciduous, Tropical Moist Deciduous and Tropical Thorn Forest types.
- The Atmakur Division comprises of Gundla Brahmeswaram Wildlife Sanctuary (GBM), Nagarjuna Sagar Tiger Reserve (NSTR) and Rollapadu WLS. Out of 1288.81 Km^2 of forest area, an area of 536.16 Km^2 is included in Nagarjuna Sagar Tiger Reserve (NSTR), 277.88 Km^2 in Gundla Brahmeswaram Wildlife Sanctuary (GBM) & 5.20 Km^2 in Rollapadu Wild Life Sanctuary.
- There are 47 Vana Samrakshana Samities (VSSs) in the Division. An area of 135.31 Km^2 forests, which is 10.5% of the notified forests, is under the management of the VSSs.
- The forest cover in the Division based on the interpretation of IRS R2 LISS III 2012 data (Oct-2012) is 627.95 Km^2 which is 29.15% of the Geographical area. In terms of the forest canopy cover density classes, the Division has 1.74 Km^2 of

Very Dense Forests, 300.11 Km^2 of Moderately Dense Forests and 326.10 Km^2 of Open Forests. The area of the Scrub is 357.92 Km^2, Non-Forests 241.43 Km^2 and Water Bodies is 58.47 Km^2.

Nandyal Division:

- Nandyal Forest Division lies in the south-eastern part of Kurnool district. The rock formation consists of purple shaley lime stone, shale flags, grey lime stone and flags.
- The notified forest area of the Division is 1066.46 Km^2 which is 41.02% of the geographical area. The entire forest area is Reserved Forest.
- As per Champion and Seth's classification, the forests of Division fall under Tropical Dry Deciduous, Tropical Moist Deciduous and Tropical Thorn Forest types.
- A part of Gundla Brahmeswaram (GBM) Wildlife Sanctuary falls in this Division. Out of the total area of 1,066.46 Km^2 of notified forests, an area of 371.81 Km^2 is included in the GBM WLS.
- There are 51 Vana Samrakshana Samities (VSSs) or Joint Forest Protection Committees (JFPCs) in the Division. An area of 166.84 Km^2 forests, which is 15.64% of the notified forests, is under the management of the VSSs.
- The forest cover in the Division based on the interpretation of IRS R2 LISS III 2012 data (Oct 2012) is 1033.54 Km^2 which is 39.75% of the geographical area. In terms of the forest canopy density classes, the Division has 4.58 Km^2 of Very Dense Forests, 672.15 Km^2 of Moderately Dense Forests and 356.81 Km^2 of Open Forests. The area of the Scrub is 28.70 Km^2, Non-Forest 1.97 Km^2 and Water Bodies 2.25 Km^2.

Prakasam District:

Prakasam District comprises of Markapur WLM and Giddalur Division whose forest, protected area and land use pattern is being described below:

Markapur WLM Division:

- Markapur WLM Forest Division lies in the south-eastern part of Prakasham district. The seasonal rivers like Gundlakamma, Sagileru, Musi, Paleru and Manneru flow through the Division.
- The notified forest area of the Division is 2476.39 Km^2 which is 34.30% of the geographical area. The status of entire forest area is Reserved Forest.
- As per Champion and Seth's classification the forests of Division fall under Southern Tropical dry deciduous, as the predominant and climatic climax forest in the Division. The Southern Tropical Thorn Forest also occurs in low elevations and in plains.

- Parts of 2 Protected Areas viz., the Nagarjuna Sagar Srisailam Tiger Reserve (NSTR) and Gundla Brahmeswaram (GBM) Wild Life Sanctuary, fall in the Division. An area of 1039.51 Km^2 is included in the Nagarjuna Sagar Srisailam Tiger Reserve and 55.45 Km^2 in the Gundla Brahmeswaram Wild Life Sanctuary (GBM).
- There are 93 Vana Samrakshana Samities (VSSs) in the Division. An area of 347.14 Km^2 forests, which is 14.01% of the notified forests, is under the management of VSSs.
- The forest cover in the Division based on the interpretation of IRS R2 LISS III 2012 data (Dec-2012) is 1397.38 Km^2 which is 19.35% of the geographical area. In terms of the forest cover canopy density classes the Division has 7.00 Km^2 of Very Dense Forests, 207.36 Km^2 of Moderately Dense Forests and 1183.02 Km^2 of Open Forests. The area of the Scrub is 1148.03 Km^2, Non-Forest 49.39 Km^2 and Water Bodies 25.95 Km^2.

Giddalur Division:

- Giddalur Forest Division lies in the south-eastern part of Prakasam District. The rocks in the Division are Sandstone mixed with quartzite. Occasional shales are the characteristic rock formations on the Veligonda and at their extremes bordering Kanigiri, the rocks gradually change into Gneisses or Granite composition.
- The notified forest area of the Division is 1,948.60 Km^2 which is 18.72% of the geographical area. Reserved, Protected and Un-classed Forests constitute 1908.69 Km^2 (97.95%) and 39.91 Km^2 (2.09%) of the forest area respectively.
- As per Champion and Seth's classification, the forests of the Division fall under Southern Tropical Dry Deciduous and Southern Tropical Thorn Forests.
- A part of one Protected Area, the Gundla Brahmeswaram (GBM) Wildlife Sanctuary falls in the Division. An area of 444.76 Km^2 of the Division is included in this WLS.
- There are 110 Vanasamrakshana Samities (VSSs) in the Division. An area of 287.08 Km^2 forests, which is 19.16 % of the notified forests, is under the management of VSSs.
- The Forest cover in the Division based on the interpretation of IRS R2 LISS III 2012 data (Nov/Dec 2012) is 1396.02 Km^2 which is 13.41% of the Geographical area. In terms of the forest canopy cover density classes, the Division has 24.64 Km^2 of Very Dense Forests, 468.06 Km^2 of Moderately Dense Forests and 903.32 Km^2 of Open Forests. The area of the Scrub is 779.63 Km^2, Non-Forests 31.22 Km^2 and Water Bodies 1.34 Km^2.

Guntur District:

Guntur District comprises of Guntur Division whose forest, protected area and land use pattern is being described below:

Guntur Division:

- Guntur Forest Division comprises of the entire District. The Division has four physio graphic zones-the sea board, the plains, ghats and hills rising gently to an altitude of 500 m and the 'U' shaped Nallamalai hills skirting Macherla to its west and Markapur and Kurnool Divisions to the east. The other hill ranges of the Division are Venkatayyapalem and Kondaveedu of Sattenapalli and Narasaraopet.
- The notified forest area of the Division is 1411.10 Km^2, which is 13.28% of the geographical area. The entire forest area is Reserved Forest.
- As per Champion and Seth's classification, the major Forest types of Division are Coastal Forests and Inland Forests. In Coastal Forests, Mangroves and Dry evergreen Forests are present. Whereas, Inland Forests contains Southern Dry Mixed Deciduous, *Hardwickia binata* and *Acacia arabica* forests.
- The Division contains a part of the Krishna Wildlife Sanctuary (KWS). An area of 81.99 Km^2 of the Division is included in the Krishna Wildlife Sanctuary (KWS).
- There are 180 Vana Samrakshana Samities (VSSs) in the Division. An area of 260.80 Km^2 forests, which constitutes 16.10% of the notified forests, is under the management of the VSSs.
- The forest cover in the Division based on the interpretation of IRS R2 LISS III 2012 data (Nov 2012) is 402.95 Km^2 which is 3.79% of the Geographical area. In terms of the forest canopy cover density classes, the Division has 124.24 Km^2 of Moderately Dense Forests and 278.71 Km^2 of Open Forests. The area of the Scrub is 942.96 Km^2, Non-Forest 108.50 Km^2 and Water Bodies 22.50 Km^2.

2.1.13 Socio-Economic Environment

The socio economic profile is delineated below for the districts through which the proposed alignment passes. The different sources used for generating the socio economic profile are Socio-Economic Survey of GoAP 2014-15, Ministry of Micro Small and Medium Enterprises and Census of India 2011.

Ananthapuramu District:

- Ananthapuramu district is situated in the Rayalseema region of Andhra Pradesh and is the largest district in terms of area in Andhra Pradesh.
- The district is bounded on the north by the Kurnool District, on the southeast by Chittoor District, on the east by YSR District, and on the west and southwest by Karnataka state.

- The district's GDP at constant (2004 – 05) prices was INR 17,343 crore in 2013-14.
- The district is not endowed with perennial rivers. Pennar, Jayamangala, Chitravathi and Vedavati are the important rivers in the district.
- The district has rich deposits of good mineral resources like iron ore, lime stone, cement grade gold deposits, diamonds deposits. White shale, dolomite and barite deposits are also available.
- Anantapur District's literacy rate of its urban population is 74.69 per cent which is much above the national average. The district's literacy rate has grown from 56.13 per cent to 63.57 per cent over the years 2001 – 2011. The district population constitutes 4.83 per cent of the state's population. The district has a sex ratio of 977 females to every 1000 male.
- The district has been dived into 3 revenue divisions namely Ananthapur division, Dharmavaram division and Penukonda division. Ananthapur division has 20 mandals, Dharmavaram 17 and Penukonda has 27 mandals. In total the district has 64 mandals.
- The district has 353 Km of National Highways, 3489 Km of PWD roads, and 7157 Km of Panchayat roads. National Highway (NH) 7 and NH 42 are the major national highways that pass through the district.
- Anantapur Railway Station is the main station that serves the district. It belongs to the South Central Railway zone.
- Tirupati Airport is well connected to the Anantapur via Anantapur-Tirupati Highway. Bangalore International Airport is at 220 km to the district and connected via NH 7.
- Krishnapatnam Port well connected to the district via State Highway (SH) 58, SH 34 and Anantapur-Tirupati Highway.

Kurnool District:

- Kurnool district lies in the Rayalseema region of AP. Kurnool is surrounded by districts of Mahabubnagar district of Telangana to the north, Anantapur district, Kadapa district to south, Prakasam district to east and Bellary of Karnataka to the west.
- Nallamalas and Erramalas are the two important mountain ranges in the district running in parallel from North to South.
- The district's GDP at constant (2004 – 05) prices was INR 15,673 crore in 2013-14.
- The district is bounded by Rivers Tungabhadra and Krishna on the north. The Pennar river also passes through the district.

- Kurnool district is endowed with good mineral resources. The important minerals found in the district are Iron ore, Dolomite, lime stone, ochre, quartz stealite and silica.
- Kurnool District's literacy rate of its urban population is 72.49 per cent which is much above the national average. The district's literacy rate has grown from 53.22 per cent to 59.97 per cent over the years 2001 – 2011. The district's population constitutes 4.79 per cent of the state's population. The district has a progressive sex ratio of 988 females to every 1000 males.
- Kurnool city is the district headquarters of Kurnool district. Kurnool District comprises 3 Revenue Divisions, 54 Revenue Mandals, 53 Mandal Parishads, One Municipal Corporation, 3 Municipalities, 899 Gram Panchayats (Notified – 7, Non notified – 862) and 920 Revenue Villages.
- The district has 228 Km of National Highways, 3581 Km of PWD Roads, and 6548 Km of Panchayat roads. National Highway (NH) 7 and NH 18 are the main national highways that pass through the district.
- The Hyderabad International Airport is only 199 Km from Kurnool and is well connected though National Highway (NH) 7. The four railway stations in Kurnool District are Kurnool city, Adoni, Nandyal and Dhone junction. Kurnool railway station is the major station of the district.
- The Krishnapatnam Port is 354 Km from Kurnool and is connected via Ballari – Krishnapatnam Port.

Prakasam District:

- Prakasam district is one of the coastal districts of Andhra Pradesh. The areas in the district which are near the coast are plain and fertile. The district has variety of soils like black cotton, red soil, red sandy loamy and sandy loamy.
- District is located in the Southeastern part of the state and is bounded by Guntur district in the north, Mahabubnagar district of Telangana in the northwest, Kurnool district in the west, Nellore district in the south, YSR Kadapa district in the southwest and Bay of Bengal to the east. The district headquarters are located at Ongole, the largest city in the district.
- The district's GDP at constant (2004 – 05) prices was INR 16,026 crore in 2013-14.
- The principal minerals found in the district include barytes, Quartz silica and iron ore.

- Prakasam District's literacy rate of its urban population is 78.43 per cent which is much above the national average. The district's literacy rate has grown from 63.08 per cent to 57.38 per cent over the years 2001 – 2011. The district's population constitutes 4.02 per cent of the state's population. The district has progressive sex ratio of 981 females to every 1000 males.
- Ongole city is the administrative headquarter of the district. There are 3 revenue divisions in the district anmely, Ongole division, Kandukur division and Markapur division. The district constitutes of 56 Mandals.
- The district has 178 Km of National Highways, 3309 Km of PWD Roads, and 7906 Km of Panchayat roads. The district's major highway – National Highway 5 (NH 5) runs along India's east coast through the states of Odisha, Andhra Pradesh and Tamil Nadu.
- Vijaywada airport and Chennai International airport are the closest to the district and are well connected via roads.
- Railways in the district comes under South Central Railway zone and has good connectivity on Howrah- Chennai main line. Ongole is one of the main stations of this district.
- The Visakhapatanam port, Chennai Port, Krishnapatnam port and Kakinada port are the closest to the district.

Guntur District:

- Guntur is one of the 9 Coastal districts of Andhra Pradesh. It is bounded by Krishna & Nalgonda districts on the North, by Prakasam and Mahabubnagar districts on the West, by Prakasam district on the South and by Krishna district, and the Bay of Bengal on the East. The district has a coastline of 100 Kms.
- Guntur City is the largest city in the district and administrative center of Guntur District. Paddy, tobacco, cotton and chillies are the main agricultural products cultivated in the district.
- The district's GDP at constant (2004 – 05) prices was INR 23,127 crore in 2013-14.
- Krishna is the main river, which traverses 250 kms in the district, irrigating an area of nearly 5 lakh. Chandravanka, Naguleru and Gundlakamma are the 3 major rivulets.
- Guntur district has deposits of limestone, clay, quartz, copper, and lead. Lime stone is abundantly available in Pidiguralla, Macherla, Pondugula and Tadipalli

areas. Copper deposits are found at Agnigundala. Napa stones are found in abundance in various places in this district.

- Guntur District's literacy rate of its urban population is 78.03 per cent which is much above the national average. The district's literacy rate has grown from 62.54 per cent to 67.40 per cent over the years 2001 – 2011. The district's population constitutes 5.78 per cent of the state's population. The district has a progressive sex ratio of 1003 females to every 1000 males.
- Guntur City is the district headquarters of the district. Guntur district is divided into 3 Revenue divisions: Guntur, Tenali and Narsaraopeta. The district is divided into 57 Mandals and 729 revenue villages.
- The district has 148 Km of National Highways, 3994 Km of PWD Roads, and 7445 Km of Panchayat roads. National Highway (NH) 16 and NH 214A are the major highways that pass through the district.
- Vijaywada airport is only 55 Km from Guntur and is connected via National Highway (NH) 5 and the Visakhapatanam Airport is 392 Kms from Guntur City via NH 5. Airports at Hyderabad, Chennai, and Bangalore are also well connected to Guntur through roads.
- Guntur junction is the major intercity railway station in the city of Guntur and falls under South Central Railway zone of Indian Railways.
- Kakinada Port at 256 km and Visakhapatanam port at 389 Km; via NH 5. Other ports such as Kakinada port and Krishnapatnam are also well connected to city.

2.2 Climatic Conditions of the Region

Ananthapuramu District:

Anantapur has a semi-arid climate, with hot and dry conditions for most of the year. Summers start in late February and peak in May with average high temperatures around the 37 °C (99 °F) range. Anantapur gets pre-monsoon showers starting as early as March, mainly through north-easterly winds blowing in from Kerala. Monsoon arrives in September and lasts until early November with about 250 mm of precipitation. A dry and mild winter starts in late November and lasts until early February; with little humidity and average temperatures in the 22–23 °C (72–73 °F) range. Total annual rainfall is about 560 mm).

Kurnool District:

The climate of the district is tropical with temperatures ranging from 26°C to 46°C in the summer and 12°C to 31°C in the winter. January, February and March months are

usually pleasant with moderate winds from South-East. April and May are hottest months of the year, during these months the wind shifts to South West with increased force and brings welcome showers by the end of May. During the succeeding four months the wind blows from western side and brings fair quantum of rainfall. By the end of September the wind is light and pleasant forecasting the onset of North East monsoon. In November and December the weather is fine, rainfall is rare and wind is light with occurrence of heavy dew. Kurnool is having the rainfall range of 500 mm to 750 mm. Normal rainfall of Kurnool is 670 mm. Out of which nearly 68% is being received from South West monsoon and 22% will be received during North East monsoon Period. Rainfall in Kurnool is mostly erratic, insufficient and unevenly distributed. Hence, drought or floods is a common phenomenon.

Prakasam District:

The tropical climate of the district is manifested in hot and humid summer, moderately monsoon and mild winter season. May is the hottest month of the year. The maximum temperature during the day time was recorded as 46.7^0C and December the coldest with the temperature during the day time falling down to about 31^0C. The night temperature in winter can be as low as 14^0C. The months of December, January & February are considered to have pleasant climate.

Guntur District:

The climate of Guntur is tropical. The average temperature is warm to hot year round. The summer season (especially during May/June) has the highest temperatures, but these are usually followed by summer monsoon rains. The winter season (from October to February) is the most enjoyable with a pleasant climate. Winter months may feature more rainfall than summer but there are dry spells during the winter season. The wettest month is July. The average annual temperature is 28.5^0C and annual rain fall is about 905 mm. Rain storms and hurricanes are common in the region during the rainy season, which starts with the monsoons in early June. Hurricanes may occur any time of the year, but occur more commonly between May and November.

As per Environmental Impact Assessment Notification, 2006 and its amendment 2009, the Project will fall under **Category A** and would require prior Environmental Clearance from MoEF, GoI and hence an EIA study will be required to be carried out for the purpose. For carrying out the EIA study, the Terms of Reference (ToR) has been proposed.

3.0 Scope of the Study

The scope of the environmental report is given below:

- Reconnaissance survey, environmental screening and categorization framework for the proposed project to include the environmental aspects from the planning stage of the project.
- Review of National, state and local environmental regulatory requirements on environmental aspects, including necessary clearances from State and Central Government in the context of proposed expressway project.
- Collecting secondary baseline data from relevant sources for various environmental attributes around the project site.
- Conduct environmental analysis of alternatives for different project components and provide specific inputs to technical analysis of alternatives.
- An environmental impact assessment for the proposed project to identify and quantify potential impacts of the project.
- Impact prediction and assessment of key aspects of the project such as ambient air, noise, water etc., and assessment of other aspects of the project with sustainable mitigative measures.
- Suggesting a typical environmental management plan with appropriate line estimates duly addressing the key environmental attributes.
- Suggesting post project environmental studies to be carried-out.

4.0 Terms of Reference for EIA study

4.1 Study Area

A detailed study of all the environmental features falling within the immediate corridor of impact, which has been considered as 500 m on both sides from center line of road. The other sensitive environmental issues such as protected areas notified under wildlife (protection) Act 1972, critically polluted areas as notified by Central Pollution Control Board, notified Eco-sensitive areas, interstate boundaries and international boundaries, water bodies of ecological significance etc., will be identified within 15 km from the alignment. The detailed information from the RoW as well as the area falling within 500 meters on the either side road will be collected from primary sources and the other environmental features within 15 kms aerial distance as explained above will be studied from secondary data sources. Rapid EIA studies are being carried out for the proposed expressway project in accordance with the Environmental Impact Assessment Notification, 2006 and amendment thereof as well as MoEF EIA Guidance Manual, 2010. The Environmental Baseline data are being generated based on the EIA Guidance

Manual, 2010. Environmental Baseline monitoring report will be prepared as per Standard ToR given in EIA guidance manual by MoEF and the same is enclosed in Appendix V. The details of the EIA study is given below.

4.2 Description of the Environment

The baseline data on various environmental features will be collected from secondary and primary sources from field surveys and investigations in order to describe the environmental settings of the project area. The data on different environmental components along the project corridor will be collected by site reconnaissance survey in order to establish environmental condition of the project area. The study area covers 15 km either side of the project stretch.

4.3 Baseline Data Generation

(a) Secondary Data Collection:

Secondary data will be collected from secondary sources like publishes, literature from various government and private agencies, NGOs, or institutions on physical, biological and social components of environment. The data will be reviewed for establishing existing environmental and ecological status within the project area.

(b) Field Survey:

Field survey will be carried out for the identification of the environmental sensitive zones within the study area and physical verification of all the identified sensitive zones with respect to the location of the project alignment and activities proposed. Field surveys are included with the measurement of environmental quality in terms of ambient air quality, water quality, soil quality, background noise level and ecology (Flora, fauna and roadside trees). Procedure for the measurement of environmental quality surveys will be carried out as per guidelines of the Ministry of Environment and Forests, Government of India. Following details on different environmental features are being collected either from the secondary sources or from field surveys.

(i) Physical Environment:

- **Topography:** Topography, ground conditions, altitude, slope, etc.
- **Soil and Geology:** Soil type and it characteristics, soil erosion and land slide problem, geology of the area.
- **Water Environment:** An inventory survey of all water bodies located within 500 m on either side of the project road sections will be carries out. Details of rivers, streams, springs, lakes, reservoirs within 500 meters of the proposed road right of way will be collected from the site along with their usage and importance for

the local population. Study of hydrology of the project road, natural drainage of the project region, existing drainage pattern of the project road, runoff flow direction, possible flooding, erosion will also be collected. Information on ground water table, ground water availability in the project area, exploitation of ground water will be studied and collected from secondary sources.

- **Meteorological Data:** Meteorological data covering maximum and minimum wind speed, wind direction, rain fall, relative humidity and temperature for last 30 years periods will be collected from the nearest Indian Meteorological Department (IMD) station i.e Gannavaram station, which is located near to the Guntur district. History of special weather phenomenon like cyclones, cloud bursts, etc., will be collected from the nearest meteorological station for a period of 50 years. The wind velocity, wind direction and wind rose, rainfall, temperature and relative humidity along the proposed alignment are being recorded using a micro-meteorological station during the study period.
- **Environmental Quality:** Baseline environmental quality data in terms of water, ambient air, noise levels and soil quality would be generated as follows:

  Ground & Surface Water Resources and Quality: Water samples from ground water and surface water resources along the project road alignment will be collected and analysed for the physico-chemical & biological parameters. Surface water samples will be collected from different water bodies/rivers/streams along the project stretch and ground water samples from most commonly used ground water sources along the project road. Surface water samples will be analysed for Temperature, pH, Turbidity, EC, Colour, TSS, TDS, Odour, DO, BOD, COD, TKN, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Ammonia, Chloride, Sulphate, Phosphate, Nitrate, Fluoride, Surfactants, Dissolved Iron, Copper, Zinc, Manganese, Arsenic, Lead, Mercury, Boron, Chromium, Phenols, Cadmium, Total Coliform, Faecal Coliform etc., and ground water samples will be analysed for Temperature, pH, Turbidity, EC, Colour, TSS, TDS, Odour, DO, BOD, COD, TKN, Total Hardness, Sodium, Potassium, Calcium, Magnesium, Ammonia, Chloride, Sulphate, Phosphate, Nitrate, Fluoride, Surfactants, Dissolved Iron, Copper, Zinc, Manganese, Arsenic, lead, Mercury, Boron, Chromium, Phenol, Cadmium, Total Coliform, Faecal Coliform etc.

  Ambient Air Quality: Ambient air quality monitoring process is under progress all along the project stretch at 20 locations covering different category of land use (residential, commercial/industrial, sensitive zones like schools, college and hospital) with a frequency of twice a week for one month. The ambient air quality monitoring are being carried out for Particulate Matter (size less than 10 µm) or

PM_{10}, Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$, Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Carbon Monoxide (CO) by following the MoEF guidelines.

Noise Environment: The noise monitoring will be carried out along the project alignment covering sensitive locations such as residential, hospitals, schools, sanctuaries etc. The noise monitoring will be done for 24 hrs at each location. During nigh time and day time, equivalent noise levels will be generated for each monitoring locations to have an idea of noise pollution levels in the study area.

Soil Quality: The soil samples of different area along the project stretch will be collected for assessing the physico-chemical characteristics of the soil in the project area. The quality parameters are pH, electrical conductivity, sand, silt, clay, texture, moisture retention capacity, infiltration rate, bulk density, porosity, organic matter, nitrogen, potassium, phosphorous, Pb, iron and organic carbon.

Existing Land Use Pattern: Land use pattern will be established along the project road classifying forest area, agriculture land, barren land, urban & rural settlements, water bodies, hills etc., along the project road.

(ii) Biological Environment

Flora and Fauna: Information on vegetation within the study areas are being collected from secondary source as well as through site investigation. The vegetation study includes forest area & road side plantation within the proposed RoW. List of flora and fauna within 10 km on either side of project road will also be collected.

Ecological Sensitive Locations: Details of ecological sensitive locations, such as Wildlife Sanctuary, National Parks, Bio-Reserve etc., are being collected & studied within 10 km on either side of project road.

Ecological Studies: Terrestrial and aquatic ecological studies will be conducted along & within the proposed RoW. Common trees, shrubs, other vegetation, common fauna, rare and endangered species are surveyed, identified and studied. The roadside trees within the proposed RoW will be surveyed for botanical & vernacular name of species, girth wise enumeration etc.

(iii) Socio-Economic and Cultural Environment

Socio-economic Details: Study of demographic details including population, schedule caste, schedule tribe, literacy, occupation pattern in the settlements along the project road, economic and social conditions, life styles, etc., along the project road and study of infrastructure facilities in the settlements along the project road. The social study comprising socio-economic survey along the project

road and reflect the number and details of Project Affected Persons (PAPs) along the project road. Following data will be collected:

- Details of the properties, houses, businesses etc.
- Activities likely to be effected by land acquisition and annual financial loses.
- Data covering the vulnerable groups or persons including women, children, elderly.
- People below the poverty line, indigenous people and people in notified settlements
- Data on diseases in the locality and existing health care facilities
- Data on demography including traditional skills and sources of livelihood along the proposed site.

Places of Tourist, Historic, Archaeological and Religious Interests: Places of tourist interest, historical, archaeological and places of religious interests (if any) are identified along the project road in the immediate vicinity and also within study area (15 km on either side of the project road).

Common Resources: An inventory of common community resources such as educational institutions, health centres, recreation centres, courts, libraries, community centres, public toilets, religious and cultural features etc., situated along the project corridor are prepared.

4.4 Analysis of Alternatives to the Project Road

In-depth study of related maps, topographic sheets, physical inspection and environmental and social screening was carried out in order to find out the technically and environmentally sound, most feasible and environmental friendly alignment. Alternatives are considered for the analysis of "without" and "with" project situations and components. The selected alternatives were compared in terms of their potential social & environmental impacts, capital & recurrent costs, suitability under local conditions, institutional training and monitoring requirements. For each alternative, environmental costs and benefits were quantified and criteria for the selection of alternative was stated. Analysis of alternative includes alignment selection, finalization of bypasses, road widening to reduce the cutting of tree, minimizing the demolition of structures, grade separators, services roads, vehicular, pedestrian and cattle underpass, quarry materials, road safety, etc.

4.5 Anticipated Environmental Impacts and Mitigation Measures

The environmental impact assessment is conducted in accordance with the requirement of the Ministry of Environment & Forests (MoEF) norms and guidelines. The collected primary and secondary data are compiled and analyzed to establish a comprehensive database and assess the existing baseline environmental condition. After establishing the baseline status of the study corridor and analysis of the project proposals and activities, the potential impacts on environmental components would be identified for pre-construction, construction and operational stages of the project. On the basis of the existing baseline environmental condition within the project area and the nature and extent of activities envisaged in construction/operation phase, **the impacts would be identified and assessed for "Without and With Project Scenario"** during construction and operation phases of the project**.** Wherever practicable, a quantitative analysis will be performed for the impacts by using appropriate modeling method. All potential direct and indirect influence due to the proposed project will also addressed. The scope of work not confined only to alignment but the impacts due to the associated construction activities assessed. The following aspects are given due importance during assessment of impacts and recommending remedial measures:

- Alignment of the project road and topographical changes.
- Roadside drainage to avoid water logging, erosion & environmental degradation.
- Impact on soil along the project road.
- Impact of solid waste generated and solid waste management plan.
- Impact on borrow area and quarries.
- Impact on road safety.
- Impact on ambient air quality due to air pollution during construction activities and vehicle movement. Prediction of ambient air quality due to projected vehicular traffic would be carried out using computer based CALRoads View software (CAL3QHCR).
- Impact of noise level during construction activities and vehicle movement. Prediction of noise levels would be carried using Federal Highways Noise Administration (FHWA) model during operation phase.
- Assessment of impacts of road construction on ground and surface water sources in the study area.
- Impact of solid waste generated during construction phase of the project.
- Nature, quantity and disposal of construction spoils, wastes and waste water.
- Impacts of flora and fauna and ecological resources due to construction and operation of the project.

- Public health & sanitation, and occupational health & safety of construction workers.
- Impact on safety of local people during construction and operation phases.
- Population affected and socio-economic impacts.

4.6 Public Consultation and Information Disclosure

Public consultations will be conducted in the affected areas along the project road. The issues discussed during public consultation will be incorporated in the design framework, environmental management and mitigation plan.

4.7 Environmental Monitoring Programme

Environmental monitoring plan for construction and post construction phases of the project road will be formulated to ensure effectiveness of implemented environmental mitigation measures. Cost of Environmental Monitoring Plan for construction and post construction phase of the project will be given in EIA/EMP report.

4.8 Environment Management Plan

After detailed analysis of all the environmental impacts and issues, a proper and adequate Environmental Management Plan (EMP) will be prepared with the aim to avoid, mitigate or eliminate the adverse impacts due to the project. This will cover roles and responsibilities for mitigation operations, emergency response procedures & supervision, financing, monitoring and reporting. EMP also includes the prospects of environmental enhancement within the project area. EMP will envisage the plans for the proper implementation of mitigation measures to reduce the adverse environmental impacts due to project activities during construction and operation phase. The following issues are addressed in the EMP:

- Preventive, mitigation, compensatory & enhancement measures for minimization & abatement of the undesirable impacts caused during the construction and operation stage.
- Details of management plans (compensatory plantation, solid waste management plan, borrow area management plan, occupational safety and health plan) including their implementation schedule and supervision programme.
- Identified/recommended institutional set up for implementation of the EMP including institutional requirements, staffing and training.
- Environmental monitoring programme during construction and operation phase including performance indicators, monitoring mechanisms, implementation programme and cost.

- Resettlement action plan for affected families as per NHAI Policy and NRRP 2007.
- Environmental Management Budget considering the environmental aspects for the project.

4.9 Structure of EIA Report

EIA report is followed the structure as per EIA Notification, 2006 and consists of the following Chapters:

- Introduction
- Project Description
- Analysis of Alternatives (Technology and Site)
- Description of the Environment
- Anticipated Environmental Impact & Mitigation Measures
- Public Consultation
- Resettlement and Rehabilitation Plan
- Project Benefits
- Environmental Monitoring Program and Environmental Management Plan
- Summary & Conclusion